

Technical Installation & Operation Manual DKOS

KWT Overflow

Type DKOS



2004 KWT® Waterbeheersing BV

Foreword:

All products are designed and constructed according to the specifications as written in the order conformation. Never use the product for any other means or applications than stated. This could result in premature failure of the product risk safety of personnel. Without any exception, the products are not designed to bear or carry any loads of the civil construction

KWT products will be virtually drop-tight at their working pressure if installation has been carried out correctly. Better seal can be expected at applications with on seated pressure. The responsibility of drop-tight installation lies primarily with the installing contractor

Phrases in this manual who need special attention are marked as follow:

-  Gives the user suggestions and tips to carry out instructions more easily.
- Remarks, with additional information.
- Informs user for possible problems.

-  The user can cause serious jury to himself or others or can damage the product.

ⓘ When the Overflow slide is supplied with or executed afterwards with a actuator, the complete system should meet the machinery guide lines.

Contents

- Foreword
- 1. Introduction
 - 1.1 Product
 - General
 - Purpose of usage
 - Installation & Operation stipulations
 - 1.2 Technical Specifications
- 2. Safety
 - 2.1 General
 - 2.2 Safety, Health and Environmental Risks
 - 2.3 Safety Precautions
- 3. Transport & Storage
 - 3.1 Transport
 - 3.2 Storage
- 4. Installation & Erection
 - 4.1 General
 - Warranty
 - Safety Aspects
 - 4.2 Preparation prior to mounting
 - 4.3 Mounting with chemical anchor bolts
 - 4.4 Applying pourmould
 - 4.5 Mounting with pour anchors
 - 4.6 Inspection prior to operation
- 5. Operation
 - 5.1 General
 - Safety Aspects
 - 5.2 Operation Instructions
 - Specifications
 - Opening and Closing
 - 5.3 Failure
- 6. Cleaning & Maintenance
 - 6.1 General
 - 6.2 Maintenance & Inspection
- 7. Discard
 - 7.1 General
 - 7.2 Removal
- Appendix
 - A. Drawings
 - B. Instructions chemical anchor bolts
 - C. HDPE Properties
 - D. Characteristic values of Material

I. Introduction

I.1 Product

General

The Overflow slide type DKOS is constructed with HDPE guide rails housed within a Stainless Steel 316 frame, non-rising spindle/s and POM nut blocks. Where the DKOS has two spindles these are coupled via a common shaft and two gearboxes to transmit power, allowing the DKOS to be operated from one side. The DKOS is operated via the Handwheel and is normally clockwise-closing.

Purpose of usage & Principle of functioning

The DKOS weir penstock has two weir plates which move independently to each other, one allows water flow underneath, and the other over the top. The DKOS can be used as a variable weir level for accurate control of the upstream water level, however it can also be lifted clear of the channel to flush silt or discharge water during high flows.

The DKOS is well suited for applications involving surface water, waste water plants, sewage systems etc. The DKOS can be operated via a number of manual options, or using electricity.

Installation & operation stipulations

Read this instruction guideline carefully before installing the DKOS.

Make sure you have taken all necessary safety precautions into account before starting. All legal and local regulations have to be followed precisely.

Installation of the DKOS should be only be carried out by skilled and therefore qualified personnel only. In case of any doubt, please contact the supplier immediately

I.2 Technical specifications

Materials of Construction	
Slide	AISI 316L or 304
Profiles	AISI 316L or 304
Frame	AISI 316L or 304
Spindle	AISI 316L
Back plate	HDPE
Sealing	EPDM Seal compound
Spindle block	POM

Table 1: Technical specifications

2. Safety

2.1 General

In this chapter all safety precautions of the DKOS are discussed. It is most important that everybody who operates the DKOS is familiar with the contents of this chapter.

The most significant risks involving mounting and operating of the DKOS are mentioned in paragraph 2.2. In paragraph 2.3 please adhere to the following safety precautions. All personnel must comply with the installing contractor safety policies.

2.2. Safety, Health and environmental Risks

The following risks should be regarded:

- Danger of trapping of body parts/clothing when mounting or operating.
- Electrical dangers during mounting or maintenance.
- Falling during hoisting.

2.3 Safety precautions if applicable.

- Unsafe situations or defects should reported to the responsible person.
- Make sure that the power supply to the actuator has been isolated during installation or maintenance.
- Qualified personnel should only carry out Electrical and mechanical work
- Wear all necessary P.P.E. Secure all loose clothing/hair before operation.

3. Transport and storage

3.1 Transport:

The DKOS is to be transported with the slide facing above on a matching pallet size.

The DKOS can be lifted with “soft” slings. The slings must only be placed on the lifting points provided.

-  All necessary lifting should be carried out by fully trained personnel
-  Only lift the DKOS with lifting slings and a lifting bar.

3.2 Storage

It is recommended to store the DKOS flat, free of dust, dirt and moisture

4. Installation & Erection

4.1 General

This chapter describes how the DKOS should be taken into operation. In this manual the installation with chemical anchor bolts and with jacking bolts is also described.

In the paragraph 4.3 and 4.4 the installation is explained step by step. In paragraph 4.6 the required actions prior to operation are described.

Warranty

It is the responsibility of the purchaser to inspect the supplied KWT products for possible defects and that all ordered items are present at arrival. Missing parts or defects should be reported to KWT immediately and not installed until the problem is rectified. The warranty will be deemed void if:

- The items supplied are not installed in the manner set out in this manual
- The products are modified in any way without the prior approval of the supplier/manufacturer
- The items are damaged due to mis-use, vandalism or overload.

All claims for warranty are subject to a full inspection by the supplier/manufacturer. KWT/ACE maintain the right to refuse claims for warranty where the inspection proves the damage to be the fault of another party

Safety Aspects:

The installing contractor is considered to be acquainted with the safety procedures as mentioned in chapter 2.

Face Mounting, Channel Wall Mounting

4.2 Preparation prior mounting

Check the mounting supplies

- 1) EPDM compound (15mm thick)
- 2) EPDM glue (in a small canister)
- 3) A white pencil
- 4) A drill can
- 5) Tube of copper grease
- 6) Chemical anchor capsules and accessories

Check the concrete wall

- 1) Check the concrete wall before installing the DKOS, to ensure the wall is smooth. For this application, it is necessary to remove concrete from the bottom corners of the culvert, to ensure that the corners are square.
- 2) Correct any deviation. Any possible gravel pockets must be filled out and concrete remains must be removed.

4.3 Mounting with chemical anchor bolts

When all points in 4.2 are addressed then continue with following installation procedure:

- 1) Operate the DKOS to the fully closed position.
- 2) With suitable lifting slings and the lifting points provided, lift the DKOS up and adjust to ensure that the DKOS is vertical and level. Lower the DKOS into position, central to the opening, and ensure the weir plate is level
- 3) Mark all mounting holes.
- 4) Remove the DKOS and proceed to attach the EPDM seal as follows.

Applying the EPDM compound

The EPDM compound is attached on the back of the frame to provide a seal between the concrete wall and DKOS frame.

1. Before applying the EPDM compound to the DKOS, ensure the frame is clean and smooth.
2. Starting with the bottom edge, cut a suitable length of seal, and mark the holes onto the seal with the white pencil. Apply the seal, then continue to repeat the process with the sides.
3. Glue the corners of the seal precisely together by using the provided EPDM glue. When not glued properly it can lead to leakage between the back-plate of the DKOS and the concrete wall.
4. Grease the drill can on the outside with the copper grease to prevent ripping of the compound, then attach to a suitable drill.
5. Now drill the previously marked holes in the compound, ensuring the hole is central to the hole in the frame.

SAFETY WARNING- Make sure that contact with the EPDM glue to your skin and eyes is prevented. If this does occur, contact your doctor immediately.

Mounting the penstock

- 1) Re-position the DKOS to previous position, adjust as necessary.
- 2) With mounting accessories supplied and suitable electric drill, following chemical anchor instructions insert mounting bolts.(see appendix B)NOTE: For penstocks with a boltable flush invert, this needs to be installed first, please follow instructions for Special countersunk bolts(see appendix B)
- 3) Proceed to fit operation attachments (see section 4.5)

The curing time should be considered precisely

4.4 Operation Accessories

On some DKOS adjustable side brackets are fitted to provide additional support to the frame.

- 1) Loosen the bolts which attach the side brackets to the DKOS frame.
- 2) Lower the brackets level with the coping of the concrete
- 3) Follow the procedure for installation of chemical anchors (Appendix B)
- 4) Re-tighten the bolts attaching the brackets to the DKOS frame

Pedestals

- 1) Remove the side plates from the pedestal and attach the pedestal to the DKOS using the supplied bolts.
- 2) Place extension shaft into the operation point and align with the top hole of the pedestal. Tighten all grub screws.
- 3) Place gearbox/ Hand wheel / protection hood/ actuator into place on pedestal and attach using suitable screws.
- 4) Replace pedestal side plates.

Commissioning

Manual DKOS:

- 1) Operate the DKOS to it's fully closed position to check operation.
- 2) Operate the DKOS to it's open position, position the locking ring to prevent the plate moving past the limits, then lock into place using supplied grub screw.
- 3) Expose the DKOS to water and operate through it's full cycle.

Electrical DKOS:

- 1) Operate the DKOS to it's fully closed position, set the closed actuator limit.
- 2) Operate the DKOS to it's fully open position, set the open actuator limit. Locate the locking rings to prevent the plate moving past the limits, and lock into place using supplied grub screw.
- 3) Set the actuator torque limits for open and close, according to the order acknowledgement.

When setting the operation torques, we would recommend that the actuator is set to open on limit to prevent over-travel, and close on torque, therefore compressing the seal when closed.

Greasing:

In most cases greasing is not required, however when using a phosphor bronze spindle bush or nut, the DKOS must be operated through it's full cycle and a suitable water-resistant grease is to be applied to the spindle bush/nut at stages through the cycle.

4.6 Inspection prior to operation

- 1) Clean the DKOS thoroughly after installation.
- 2) Check the proper functioning of the DKOS by operating the DKOS through it's full travel.

☞ **If in any doubt always contact the supplier.**

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5. Operation

5.1 General

The operation of the DKOS is discussed in paragraph 5.2. In paragraph 5.3 possible failures, the causes and methods for solving.

Safety issues

The installing contractor is considered to be acquainted with the safety procedures as mentioned in chapter 2.

5.2.1. Specifications

The KWT Overflow slide, type DKOS is standard provided with:

- Polyacetal bearing house.
- AISI 316L non-rising spindle
- POM Wire block
- The Overflow slide is clock-wise closing.

5.2.2. Opening and closing:

The DKOS weir penstock has a “master” weir plate and a “slave” weir plate, which must be operated correctly to prevent damage to the DKOS. The master plate is located behind the slave plate, i.e. closest to the headwall, used for setting a pre-determined pen level. The slave plate is then used to increase the pen level by adjusting the top level of the effective weir when the two plates are used in conjunction.

NOTE: UNDER NO CIRCUMSTANCES MAY THE SLAVE PLATE BE PLACED IN IT'S LOWERED POSITION WITHOUT THE MASTER PLATE IN IT'S LOWERED POSITION, AS THIS MAY CAUSE DAMAGE TO THE SPINDLES AND FRAME.

Using a T Crank

- 1) Insert the T-crank into operation point of the DKOS
- 2) Turn the T-crank counter clockwise for opening, clockwise for closing
- 3) If a high operation torque is noticed, the DKOS must not be operated until a cause has been found and rectified

Using a Handwheel

- 1) Turn the Handwheel counter clockwise to open, clockwise to close.
- 2) If a high operation torque is noticed, the DKOS must not be operated until a cause has been found and rectified.

Using an Actuator

Before operating the actuator, it must be fully commissioned to ensure that it will not overload the DKOS or work past it's limits. For instructions on setting/operating the actuator, please refer to the manufacturer's instructions, following this procedure:

- 1) Operate the DKOS to it's fully open position, then reverse slightly before setting the open limit on the actuator.
- 2) Operate the DKOS to it's fully closed position, then reverse slightly before setting the closed limit on the actuator.
- 3) With reference to the data supplied with the DKOS, set the torque limits for open and close on the actuator.
- 4) Operate the DKOS through a full open and close cycle, in dry conditions, then with the design head of water, to check the torque levels are suitable and the gate operates correctly.

Electrical Mode:

For details on the operation in this mode, please refer to the manufacturer's instructions. This must only be carried out by competent personnel.

Manual Operation:

For full details on this mode, please refer to manufacturer's instructions.

Basic Details:

- 1) To engage the Hand wheel, operate the Hand wheel clutch lever then turn the Hand wheel until it is engaged.
- 2) Turn the Hand wheel counter-clockwise to open, or clockwise to close.
- 3) Once electricity is restored, or the actuator is operated electrically, the Hand wheel clutch will automatically disengage.

For the number of cycles to operate the DKOS please consult the order acknowledgement. The operation torque should be less than or equal to the value stated in the acknowledgement.

⚠ Never increase the operating torque by using transmission, spindle driver, enlarged lever i.e. as the maximum allowable torque will be exceeded and may lead to damage of the components.

⚠ Great care must be taken to ensure that the DKOS is not operated past it's limits, or operated when obstructed by debris etc.

5.3 Failure

Failure	Possible cause	Suggestion
DKOS is leaking between frame and wall	Wall not flat	Wall need to flattened according NEN 6722 march 1998, article 8.6
	Sealing not glued correctly	Sealing has to be renewed and installed according the installation instructions.
DKOS is leaking between slide and frame	Seal damaged	Replace seal
	Application specifications are exceeded.	Please contact supplier.
	Dirt between seal and seal face area	Remove present obstacles
	Seal does not contact seal area. ⚠ Check if the frame has not been deformed due to a non-flat wall.	Adjust screws on front to obtain a better sealing.
Operation torque is significant higher.	Wall not flat	Wall need to flattened according NEN 6722 march 1998, article 8.6
	Spindle polluted or damaged	Clean or replace spindle Please contact supplier.
	Application specifications are exceeded.	Please contact supplier.
	Dirt between seal and seal face area	Remove present obstacles
	Bearing housing not aligned properly	Replace Bearing housing according the installation instructions.
Seal damages	The threaded rods in the horizontal bar are sticking out too far.	Shorten these rods.

6. Cleaning & maintenance:

6.1 General

The DKOS is constructed in a way that minimal maintenance is required. Paragraph 6.2 describes the regulations involving regular maintenance.

6.2 Maintenance & Inspection

Minimum Requirements

For correct functioning of the DKOS, it is recommended to operate the DKOS fully through its cycle annually, and inspected for damage or obstruction monthly. The weir must also be visually inspected before each use.

Inspection:

- 1) Spindle must be straight and Dirt Free
- 2) Spindle Block must be clear of debris
- 3) Check Door and Frame seals for damage
- 4) Obstructions must be removed

Other Maintenance:

DKOS designed for modulating or heavy duty are fitted with a Phosphor Bronze Spindle Block. This is fitted with a grease nipple, which should be greased monthly with a suitable water-resistant grease. In the case of a rising spindle, the area around the bronze spindle bush should also be greased monthly as above.

NOTE: Do not grease any part of the DKOS Weir unless otherwise stated.

In an aggressive environment or in an application where extreme fouling can be expected, it is strongly recommended to increase the inspection interval.

7.0 Disposal

7.1 General

Paragraph 7.2 describes the procedure that a DKOS at the end of its life cycle can be removed safely and in an environmentally responsible way.

7.2 Removal

Dismantle the DKOS as follows:

- 1) Ensure that the DKOS is sufficiently supported before removing fixings
- 2) Remove all the mounting material from the DKOS.

Ensure that suitable precautions are in place to prevent injury whilst the DKOS is not held in place by the mounting attachments.

- 3) Remove the DKOS from the wall.
- 4) Remove the fixing materials from the wall.
- 5) Dismantle the DKOS and separate materials into suitable classifications.

Dispose of the different materials via recognised methods, and in an environmentally responsible way

Appendix B Instructions Chemical anchor bolts**Procedure for installing Chemical Anchor Attachments**

Please note that chemical anchor attachments in two forms are used for installing various elements of the DKOS Weir Penstock. The following procedure must be referred to for details of this:

Standard Chemical Anchors

Comprising of:

Stainless Steel Threaded Studding
Chemical Anchor Capsules
Drill Adaptor
Stainless Steel Nuts, Washers and Spring Washers

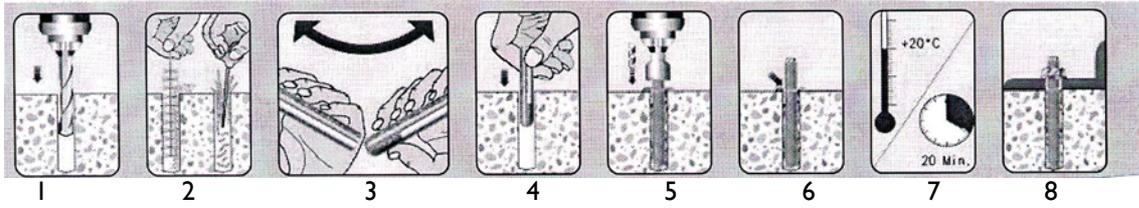
1. Drill Mounting hole in required position to the correct depth and diameter (please refer to details supplied with chemical anchors)
2. Blow out drilled hole using compressed air. (Warning, suitable eye protection to be worn)
3. Insert a chemical anchor capsule into each hole.
4. Attach a length of studding to the drill adaptor, then attach the adaptor to a rotary drill (NOTE: Do not use a hammer-action drill, as this will cause resin to escape from the hole)
5. Place the end of the threaded stud into the hole, then in one motion operate the drill at high speed, while pushing the stud through the anchor to the back of the hole. Once the back of the hole is reached, stop the drill to prevent resin escape.
6. Carefully remove the drill adaptor from the drill chuck, taking care not to move the stud.
7. Once the resin has sufficiently cured, remove the drill adaptor from the stud, however if the stud turns, leave the resin to cure further.
8. Replace the item to be mounted, then place a washer, a spring washer and a nut onto the stud and tighten by hand.
9. Once all required anchors have been installed and are fully cured, proceed to tighten the nuts evenly to the recommended torque. Where EPDM seal is used, this must be compressed evenly to ensure a good seal, however the frame must not be allowed to deform. For torque moment data, please refer to the anchor manufacturer's guidelines supplied with the anchors.

Special Countersunk Socket Anchors

Comprising of:

Threaded sockets with internal thread
Countersunk Bolts
Chemical Anchors
Special Drill Adaptor

1. Drill Mounting hole in required position to the correct depth and diameter for the threaded socket (please refer to details supplied with chemical anchors)
2. Blow out drilled hole using compressed air. (Warning, suitable eye protection to be worn)
3. Insert a chemical anchor capsule into each hole.
4. Attach the special drill adaptor to a threaded socket, then attach the adaptor to a rotary drill (NOTE: Do not use a hammer-action drill, as this will cause resin to escape from the hole)
5. Place the end of the threaded socket into the hole, then in one motion operate the drill at high speed, while pushing the socket through the anchor to the back of the hole. Once the back of the hole is reached, stop the drill to prevent resin escape.
6. Carefully remove the drill adaptor from the drill chuck, taking care not to move the socket.
7. Once the resin has sufficiently cured, remove the drill adaptor from the socket, however if the socket turns, leave the resin to cure further.
8. Replace the item to be mounted, then insert a countersunk bolt into the threaded socket.
9. Once all required anchors have been installed and are fully cured, proceed to tighten the bolts evenly to the recommended torque. Where EPDM seal is used, this must be compressed evenly to ensure a good seal, however the frame must not be allowed to deform. For torque moment data, please refer to the anchor manufacturer's guidelines supplied with the anchors.



Type	L mm	σ	σ mm	t mm	max. Nm
M10	85	M10	12	90	20
M12	95	M12	14	110	40
M16	95	M16	18	125	80

Please note that these are guide values, therefore reference should be made to the anchor manufacturer's instructions supplied with the products.

Table 1 requisite dimensions and turn moments

Temperature in °C	Mins.	Hours
The bore hole		
above 20	10	-
10-20	20	-
0-10	-	1
-5- 0	-	5

Table 2 Stated Curing Times

Appendix C High Density Polyethylene Properties

High Density Polyethylene (HDPE)

SIMONA
plastics

CEE- Safety Data Sheet according to 91/155 EWG	
Trade name: SIMONA PE-HWU-B / SIMONA PE-HWU / SIMONA PE-HD-pipe	
1. Indications to the manufacturer	SIMONAAG Tel: 06752 / 14-0 Teichweg 6 Fax: 06752 / 14-211 D-55606 Km
2. Composition / Indications to components	
Chemical characteristics	Polymer of ethylene
CAS-number	Not necessary
3. Possible dangers	Un-Known
4. First aid measures	
General comment	Medical aid is not necessary
5. Fire-fighting measures	
Suitable fire-fighting appliance	Water fog, foam, fire fighting powder, carbon dioxide
6. Measures in case of unintended release	Not applicable
7. Handling and storage	
Handling	No special regulations must be observed
Storage	Unlimited good storage property
8. Limitation of exposition	
Personal protective equipment	Not necessary

Continue Appendix C

9. Physical and chemical characteristics.

Phenotype:	Form:	Semi- finished product
	Colour:	Black
	Smell:	Not distinguishable
Change of state	Crystallite melting point	126-130 °C
Fire point		Not applicable
Inflammation temperature		Approx. 350 °C
Density		0.95 g/cm ³
10. Stability and reactivity		
	Thermal decomposition	Above approx. 300 °C
	Dangerous decomposition products	None
Besides carbon black also carbon dioxide and water as well as low molecular parts of PE will develop during the burning process. In case of incomplete burning also carbon monoxide may arise		
11. Toxic indications		
During several years of usage no effects being harmful for the health were observed		
12. Ecological indications		
No biodegradation, no solubility in water, no effects being harmful to the Environment must be expected.		
13. Waste-disposal indications		
Can be recycled or can be disposed of together with household rubbish (acc. To Local Regulations)		
	Waste key for the unused product	57128
	Waste name	Waste of polyolefin
14. Transport indications		
No dangerous product in respect to / according to transport regulations.		
15. Instructions.		
	Marking according to GefStoff V/EG	No obligation for marking
	Water danger class	Class 0 (self classification)
16. Further indications		
The indications are based on your to-days knowledge. They are meant to describe our Products in respect to safety requirements. They do not represent any guarantee of The described product in the sense of the legal guarantee regulations.		

Appendix D Characteristic values of Material

Simona

Technical information for HDPE

	Test method DIN	Dimension	SIMONA PE- HWST	SIMONA PE-HWU
Density, method C	53479	G/cm ³	0.945	0.950
Yield stress, Test piece 3	53455	N/ mm ²	22	22
Elongation at yield stress	53455	%	9	9
Elongation at tear	53455	%	500	300
Tensile-E-Module	53457	N/ mm ²	800	800
Impact strength (std. Small bar)	53453	KJ / mm ²	Without break	Without break
Impact strength when notched (U-notch)	53453	KJ / mm ²	13	12
Indentation hardness H 132 / 30	53456	N/ mm ²	43	40
Shore hardness D	53505	N/ mm ²	62	63
Crystalline melting range calorimetric	52328	K (°C)	399 – 403 (126 –130)	
Mean coefficient of thermal expansion	53752	k	1.8 . 10	1.8 .10
Heat conductivity	52612	W /mk	0.38	0.38
Behaviour in fire	4102		82	82
Dielectric strength. Methode K 20 / 5D	53481	KV / mm	50	47
Volume resistance Annular electrode	53482	Ohm .com	>10	>10
Surface resistance. Electrode A	53482	Ohm	10	10

Creep resistance Method KC	53480	V	600	600
Dielectric constant; At 300-1000 Hz. At 3 .10 Hz.	53483		2.3 2.3	2.3 2.3
Dielectric loss factor. At 300 Hz. At 1000 Hz. At 3.10 Hz.	53483		< 3.10 1.10 < 3.10	< 3.10 5.10 < 3.10
Physiological safety	BGA		JA	JA

The data specified here are guide values and may vary depending on the processing method and the production of test pieces. Unless specified otherwise, these are average values taken from measurements on extruded sheets 4 mm thick. This information cannot be automatically transferred to finished components. The manufacturer or user must check the suitability of our materials for a specific application.

Moulding compounds designation (DIN 16776, 12 / 84)

PE – HWST	natural	FM	DIN 16776-PE, EN	45	T	003 / 6
PE – HWST	dyed	FM	DIN 16776-PE, EC	45	T	003 / 6
PE – HWST	pressed FM	DIN	16776-PE, QN	45	T	003 / 6
PE – HWU	dyed	FM	DIN 16776-PE,ECLH	45	T	003 / 6
PE – HWU	pressed FM	DIN	16776-PE,QCLH	45	T	003 / 6

Appendix E EPDM Properties

EPDM Material Data sheet K420 (434)

Base Rubber		EPDM
Cellular Structure		Closed cell
Colour		Black
Density		0.15 +1-0.02 g/cc., 8.0-10.5lb/cu.f
Shore Hardness (00 Scale)		65 ± 5%
25% Compression Deflection		35-63kPa, 5-6 psi
Compression set (50% / 2Hr / 23 °C/ 24Hr rec)		20% /24hr 70°C
Water Absorption		< 5 %
Linear Shrinkage	a) 10 days 123°C	< 3 %
	b) 7 days / 70°C (after a)	< 6 %
Elongation at Break		>450 %
Tensile Strength		> 450 kPa, > 6.5 psi
Tear Strength		>0.27 kN/m, > 1.5 lb/in
Max. Use temperature	1) constant	70 °C / 160 °F
	2) intermittent	100 °C / 210 °F
Min. Use temperature		> -20°C / 1- 4°F
Air and UV Resistance		Good
Fluid Uptake*		Not Applicable
Ozone resistance		Good
Specification Class	ASTM D1056(91)	2A2,B
	SAE J 18 (79)	RE42
	FMVSS 302	PASS

- After immersion in Fuel B (30:70 toluene: isooctane) 7 days a ~23°C
- Tolerance: Plan size ± 3% Nominal Block Size : 2250 X 1000 X 40 mm
- On gauge ± 2mm 2250 X 1000 X 62 mm

This product is made to comply with the properties listed and is periodically tested for compliance. Where conditions of use and / or properties desired are not covered by the specifications we must be advised in writing so that we can monitor compliance with any additional requirements. It is the responsibility of the purchaser to ensure suitability for intended use.

Appendix F Guide for user of Stainless Steel

TAD INOX SERCIVE B.V.

Product use / handling

- 1) Always use products for the purpose and in the manner in which they were intended. No product supplied is suitable for human consumption.
- 2) Always keep dust to a minimum, where necessary, use a respiratory face mask and protective clothing.
- 3) If irritation occurs, rinse well with clean cold water, then wash thoroughly. The use of barrier creams can sometimes prevent skin irritation. If symptoms persist obtain medical advice. In the event of eye contamination or if any product is swallowed seek immediate medical attention
- 4) When working overhead or when cutting metal products, the use of protective eye glasses is advisable.
- 5) Metal products may be sharp, due care should be taken and protective gloves worn where necessary.
- 6) When welding use the extraction equipment because the fumes are hazards to the health
- 7) Metal is a good conductor of electricity. Proper precautions should be taken when working near live power lines or electrical equipment.
- 8) Plastic and metal materials can become charged. Static electricity may cause sparks when earthed.
- 9) Always use sealants, adhesives and jointing compounds in a well ventilated area. Products may give off fumes during the drying process. Avoid inhalation of vapours.
- 10) Electrical equipment and power hand tools must only be used in accordance with manufacturers instruction. Maintenance including the fitting of electrical plugs, must only be undertaken by suitably trained personnel.
- 11) Personal hygiene is important, always wash hands well, particularly before eating. The need for adequate standards of hygiene must be maintained.

Product storage

Unless specifically established to the contrary, product should be stored taking the following precautions.

- 1) Products should be stored in a clean dry area.
- 2) Packaging materials are often flammable, do not expose to a naked flame or excessive heat.
- 3) Metal can be sharp, guard and projecting ends, particularly when near pedestrian walkways.

Product Disposal

- 1) Do not burn waste products, some may give off toxic fumes
- 2) Dispose of all products in accordance with local authority regulations

Stainless Steel 316 Properties

General description

Grade 316L is an austenitic chromium-nickel steel

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo	N
0.030	0.75	2.0	0.045	0.03	16.0-18.0	10.0-14.0	2.0-3.0	0.10

Mechanical properties

At 20°C

Metric units

Proof strength Rp 0.2 (a) MPa min.	Rp1.0 (a) MPa min.	Tensile strength Rm Mpa	Elong. A(b) % min.	Elong. A 2 % min.	Hardness HRB max.
220	250	515-690	40 (c)	35	90

At 68°F

Imperial units

Proof strength Rp 0.2 (a) ksi min.	Rp1.0 (a) ksi min.	Tensile strength Rm ksi	Elong. A(b) % min.	Elong. A 2 % min.	Hardness HRB max.
32	36	75-100	40 (c)	35	90

1 Mpa = 1N/mm²

a) Rp0.2 and Rp1.0 correspond to 0,2% offset and 1,0% offset yield strength, respectively.

b) Based on $l_0 = 5,65 S_0$ where l_0 is the original gauge length and S_0 the original cross-section area.

c) NFA 49-117, 49-217 with min 45% can be fulfilled on request.

The impact strength (Charpy V) at -60 °C (-75°F) is min. 150 J (110 ft-lb).

At high temperatures metric units

Temperature, °C	Proof strength	
	Rp0.2 MPA Min.	Rp0.1 MPA Min.
50	200	230
100	180	215
150	165	195
200	150	180
250	140	170
300	135	160
350	130	155
400	125	150
450	120	145
500	120	145
550	115	140
600	110	135

Imperial Units

Temperature, °F		Proof strength	
		Rp0.2	Rp0.1
		Ksi	Ksi
		Min.	Min.
200		26	31
400		21	26
600		19	23
800		18	21
1000		17	20

Creep strength

Temperature,		Creep-rupture strength	(ISO -values)	100.000 h	
°C	°F			Mpa	ksi
		10.000 h		Approx.	Approx.
		Mpa	ksi		
		Approx.	Approx.		
550	1020	255	37.0	177	25.7
575	1065	214	31.0	137	19.9
600	1110	172	24.9	108	15.7
625	1155	137	19.9	86	12.5
650	1200	108	15.7	64	9.3
675	1245	83	12.0	46	6.7
700	1290	64	9.3	33	4.8
725	1335	49	7.1	25	3.6
750	1380	37	5.4	18	2.6

Physical properties

Density.....8.0 g/cm³, 0.29 lb/in³

Thermal conductivity

Temperature, °C	W/m °C	Temperature °F	Btu/ft h °F
20	14	68	8
100	15	200	8.5
200	17	400	10
300	18	600	10.5
400	20	800	11.5
500	21	1000	12.5
600	23	1100	13

Specific heat capacity

Temperature, °C	J/kg °C	Temperature °F	Btu/ft h °F
20	485	68	0.11
100	500	200	0.12
200	515	400	0.12
300	525	600	0.13
400	540	800	0.13
500	555	1000	0.13
600	575	1100	0.14

Thermal expansion (x10⁻⁶)

Temperature, °C	Per °C	Temperature °F	Per °F
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30-100	16.5	86-200	9.5
30-200	17	86-400	9.5
30-300	17.5	86-600	10
30-400	18	86-800	10
30-500	18	86-1000	10
30-600	18.5	86-1200	10.5
30-700	18.5	86-1400	10.5

Modulus of elasticity ($\times 10^3$)

Temperature, °C	Mpa	Temperature °F	ksi
20	200	68	29.0
100	194	200	28.2
200	186	400	26.9
300	179	600	25.8
400	172	800	24.7
500	165	1000	23.5

Corrosion Resistance

316L has good resistance in:

- Organic acids at high concentrations and moderate temperatures
- Inorganic acids, e.g. phosphoric and sulphuric acids, at moderate concentrations and temperatures. The steel can also be used in sulphuric acid of concentrations above 90% at low temperature.
- Salt solutions, e.g. sulphates, sulphides and sulphites
- Caustic environments

Stress corrosion cracking

Austenitic steels are susceptible to stress corrosion cracking. This may occur at temperatures about 60°C (140 °F) if the steel is subjected to tensile stresses and at the same time comes into contact with certain solutions, particularly those containing chlorides. Such service conditions should therefore be avoided. Conditions when plants are shut down must also be considered, as the condensates which are then formed can develop conditions that lead to both stress corrosion cracking and pitting.

In applications demanding high resistance to stress corrosion cracking, austenitic-ferritic steels, such as SAF 2304 or SAF 2205 are recommended.

Inter-granular corrosion

316L has a low carbon content and therefore better resistance to inter-granular corrosion than steels of type AISI 316. The resistance to grain boundary attack is much better for AISI 316L than for AISI 316. This is an advantage in complicated welding operations.

Pitting and crevice corrosion

Resistance to these types of corrosion improves with increasing molybdenum content. |

Gas corrosion

316L can be used in

- Air up to 850 °C (1560°F)
- Steam up to 750°C (1380°F)

Creep behaviour should also be taken into account when using the steel in the creep range.

In flue gases containing sulphur, the corrosion resistance is reduced. In such environments the steel can be used at temperatures up to 660-750°C (1100 –1380°F) depending on service conditions. Factors to consider are whether the atmosphere is oxidising or reducing, i.e. the oxygen content, and whether impurities such as sodium and vanadium are present

Applications

316L is used for a wide range of industrial applications where steels of type AISI 304 and 304L have insufficient corrosion resistance. Typical examples are: heat exchangers, condensers, pipelines, cooling and heating coils in the chemical petrochemical, pulp and paper and food industries.